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Pneumatic Braking with Soft Bumper

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Abstract: *The aim of the project is to reduce the damaged caused to vehicle during a sudden accident or collision between vehicles. The system consists of pneumatic bumper system, control unit, IR transmitter and receiver circuit. IR sensors are used to detect objects in front of the vehicle, forward signal is given to the control unit for bumper activation system. Bumper will only get activated when the vehicle speed is between the range 40-50 km per hour. In conclusion this project produces smooth application of the low-cost automation for safety.*

Keywords: Pneumatic Bumper, IR Transmitter, Arduino, Control Unit

I. INTRODUCTION

Safety is the most essential factor while purchasing an automobile. However, the increase in the cases of accident have brought us to an idea of creating a fully equipped and designed safety systemunder the "PNEUMATIC BRAKING WITH SOFT BUMPER", which is equipped by IR sensor circuit and Pneumatic bumper activation circuit. This product when through tremendous tests in our automobile vehicle and conclude to be a good fit.

II. OBJECTIVE

To sense an object in front of the vehicle at particular distance and eject the bumper before the collision or accident, to absorb the kinetic shock. Circuit should be programmed in such way to work automatically to achieve mass production.

III. COMPONENT AND DESCRIPTION

3.1 Control Unit Diagram

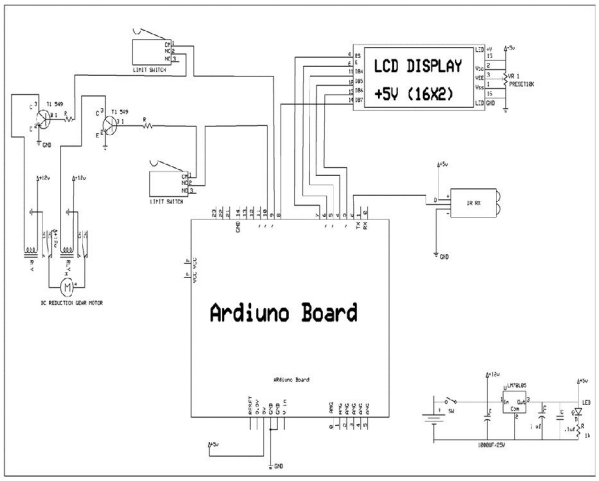

Fig. Control Unit

Sensors

A sensor is an essential component that acts as a transducer, enabling the measurement of various physical variables. However, to ensure the accuracy and reliability of a sensor's measurements, calibration is necessary. Calibration refers

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to the process of establishing the precise relationship between the measured variable and the corresponding output signal generated by the sensor. It is through calibration that a sensor becomes a valuable tool for accurate measurement.

IR Sensor

The utilization of an IR transmitting circuit is prevalent in numerous projects. This circuit functions by emitting a carrier wave at a frequency of 40 kHz, which can be adjusted according to specific requirements, under the control of a 555 timer. The deployment of carrier waves around the 40 kHz frequency range is commonly employed in television remote control systems, and integrated circuits designed for receiving such signals are readily accessible in the market.

IR Receiver

When an IR signal is transmitted, it encounters an obstacle that causes the signal to reflect. The reflected signal is then captured by the IR receiver circuit, which converts it into a control signal. This control signal is subsequently sent to the control unit. Once the control unit receives the signal, it initiates the activation of the pneumatic braking system, resulting in the application of the brakes.

IV. PNEUMATIC COMPONENT DESCRIPTON

Selection of Pneumatics

A pneumatic cylinder is composed of two main components: the piston and the cylinder itself. In this case, the cylinder is a single-acting cylinder, which means that air is used to move it forward, while a spring is responsible for its backward movement. To control the pressure, the air from the compressor passes through a regulator. The regulator has a knob that allows adjusting the pressure to the desired level. A pressure gauge is connected to the regulator to display the line pressure.

Next, the compressed air is directed through a single-acting 3/2 solenoid valve. This valve supplies the air to one side of the cylinder. The output of the directional control valve is connected to the cylinder using connectors and hoses. Additionally, one of the outputs from the directional control valve is linked to a flow control valve, which regulates the airflow to the cylinder. Connectors are used to attach the hose to each component of the pneumatic system.

Solenoid Valve with control unit

A solenoid valve is an electrical device that converts electrical energy into linear motion and force. It is employed not only to control the operation of the directional valve but also to drive various mechanical actions. Solenoids can be categorized into push-type and pull-type configurations. In a push-type solenoid, the plunger is pushed when the solenoid is electrically energized, while in a pull-type solenoid, the plunger is pulled under the same conditions. Understanding the different components of a solenoid is crucial to identify them accurately when performing repairs, servicing, or installations.

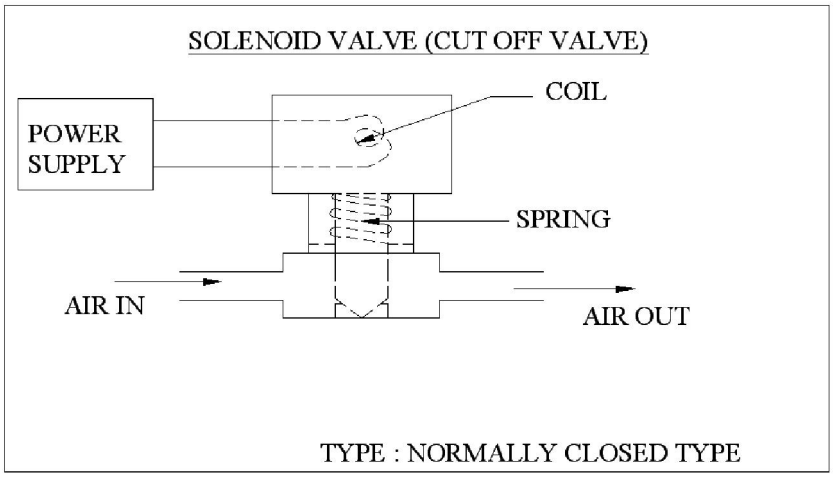

Fig. Solenoid Valve

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V. PROPOSED EXPERIMENTAL SETUP & WORK:

The compressed air, supplied by a compressor at a pressure range of 3 to 4 bar, is directed through a pipe connected to a solenoid valve featuring one input and two outputs. The solenoid valve is controlled by a timing unit. When the timing control unit is activated, the air entering the input flows out through the two outputs.

The pressure difference between the bottom and top of the piston causes the piston rod to move upward, pivoted by the control unit. This force is then transferred to a punch/rivet, causing it to move downward. An IR transmitter circuit emits infrared rays, which, if obstructed, get reflected.

The reflected infrared rays are received by the IR receiver circuit, known as the "IR RECEIVER." This circuit captures the reflected rays and generates a control signal, which activates the solenoid valve. Once the solenoid valve is activated, the compressed air flows into the single-acting pneumatic cylinder, triggering its movement. As the piston moves forward, the braking arrangement is engaged to gradually or abruptly slow down the wheel, depending on the adjustment of the flow control valve. The compressed air travels through a polyurethane tube to reach the flow control valve, which is connected to the solenoid valve.

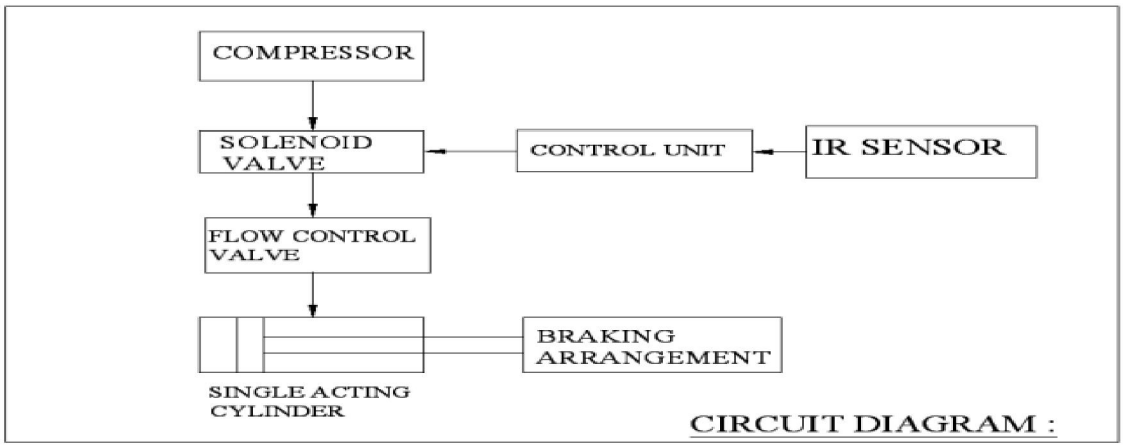

Fig. Circuit Diagram

VI. FUTURE SCOPE

Our work deals with combining the system with various different features to provide enhanced protection and safety by automatic bumper system in real time application. For that, we can incorporate some of the possible changes are:

1) Ultrasonic sensors can be used instead ofinfrared sensors.
2) Regular bumpers can be replaced by hydraulic bumpers.
3) To give an immediate signal to solenoid valve when drivers sleep infrared sensor can be used as they can sense eye blinking.
4) Limit switch can be provided to limit the minimum speed above which the system gets triggered.

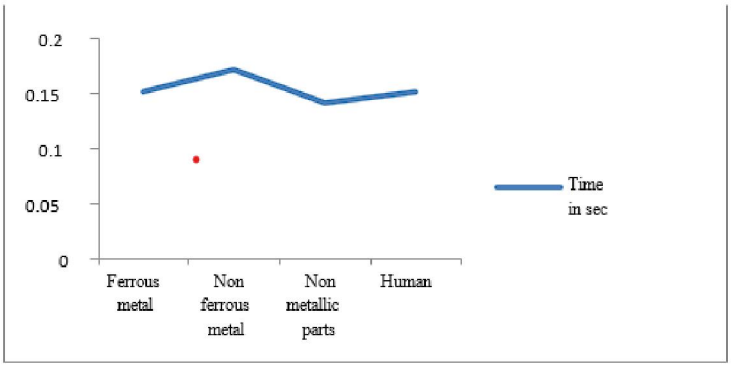

Fig. Obstacle vs stopping Time

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5) PIC can be implemented in system for further modifications like gradual slowdown in speed of vehicle.
6) Bumper design can further be enhanced to act as external air bags to reduce damage.
7) With some modifications, the project can be used with timer circuits so as to apply brakes and extend the bumper after a delay of few milliseconds so that the bumper does not ejects unless and until there's a vehicle in the caution distance.

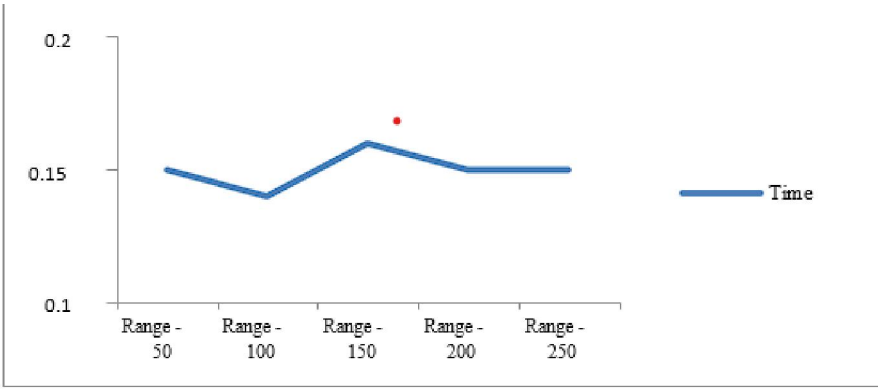

Fig. Range vs Stopping Time

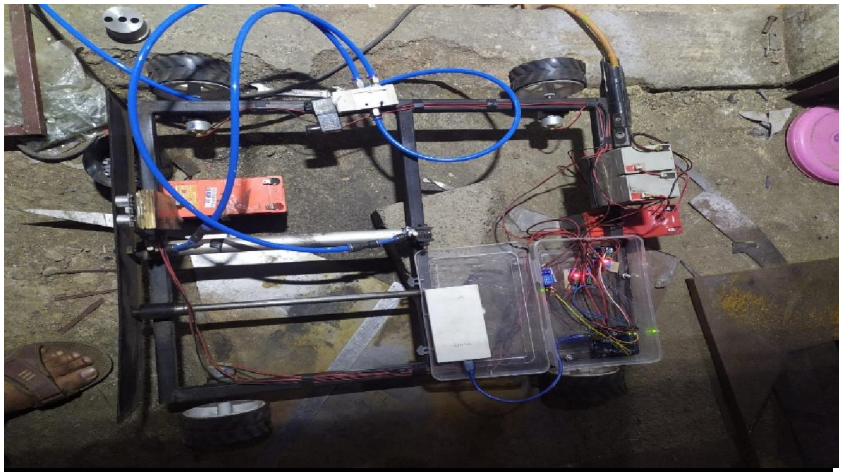

Fig. Stop Condition

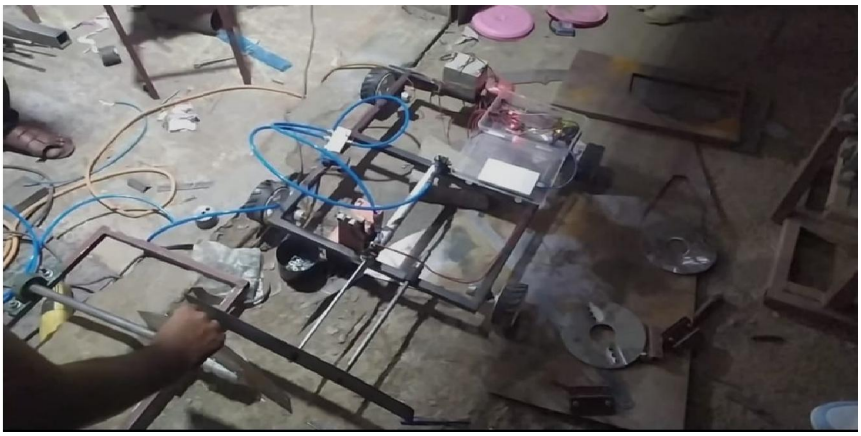

Fig. Working Condition

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VII. CONCLUSION

This project work has significant implications for future implementation in smart cars, potentially preventing loss of life. Engaging in this project provided us with valuable experience and the opportunity to apply our limited knowledge. We gained practical insights into planning, purchasing, assembling, and machining. Moreover, this project serves as a bridge between institutions and industries.

We successfully completed the project within the designated timeframe, with the pneumatic brake and soft bumper functioning satisfactorily. Throughout the process, we encountered challenges related to maintaining tolerances and ensuring quality. However, we utilized our abilities, skills, and available resources to the fullest extent.

In conclusion, the "Pneumatic Brake with Soft Bumper" project offers valuable insights into achieving low-cost automation and demonstrates the benefits of pneumatic applications, such as smooth operation. With further advancements and techniques, this project can be modified and developed to suit various applications.

Our work model demonstrated that applying 4 to 8 bar pressure from the compressor and a speed of 1 m/s resulted in the automatic forward movement of the bumper in the presence of an obstacle, effectively increasing the collision distance between vehicles. The model successfully stops the vehicle by applying brakes within a distance of 1-1.2 feet in 1 second.

Using an IR sensor on the E/R bumper, we detected barriers within a range of approximately <4m at speeds of 40 km/hr - 50 km/hr. The control signal activates the bumper and split triggering device when the obstacle is within 1-1.2 feet of the car. The bumper activation system is triggered only when the vehicle exceeds a predetermined speed limit. A proximity sensor is employed to detect this speed and transmit the signal to the control unit and the pneumatic bumper activation system, ensuring the protection of the vehicle's body.

This project offers reliability, meeting the safety expectations of passengers. It encompasses parameters sought by car consumers, including budget-friendliness, consistent and reliable performance, and protection against accidents. The project not only safeguards the car but also ensures the automatic ejection of the bumper if the other vehicle involved in the accident fails to control the impact. Thus, this safety measure can be implemented in all cars to enhance overall safety.

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